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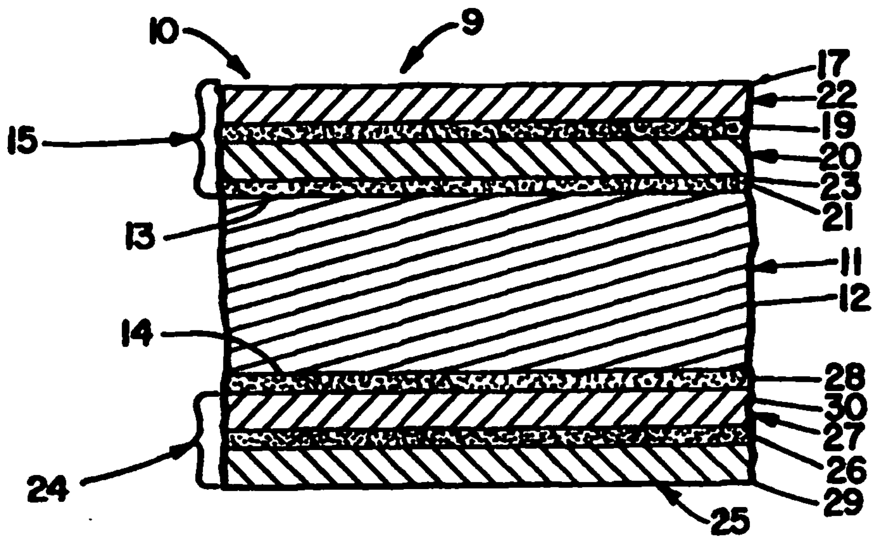
(54) Title: POLYMERIC LAMINATED DATA CARRYING DEVICES

(57) Abstract

A polymeric laminated data carrying device (9), such as a card, having a core (11) and at least one overlay (15, 24) is disclosed. The device includes polyester, polyvinyl chloride and a polar adhesive. Preferably, the adhesive has functional groups therein. Preferred embodiments of the invention include an axially oriented polyester layer (20, 27) in each of two overlays (15, 24). Each of these polyester layers is included in the device of the invention in such a manner that the axial orientation of the polyester layer is substantially parallel to the axial orientation of the second polyester layer. The invention is also directed toward methods of making a polymeric laminated data carrying device, such as a card.



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POLYMERIC LAMINATED DATA CARRYING DEVICES

FIELD OF THE INVENTION

The invention relates to multi-layered polymeric laminates and methods for making the same. In particular, the invention is directed toward polymeric laminates having polyester therein usable for data carrying devices, such as cards, and methods for making the same.

BACKGROUND OF THE INVENTION

Data carrying devices that are designed as multilayer laminates are well-known and generally used for items such as identification cards, telephone calling cards, instant cash cards, credit cards, and company identification cards. Typically, a core layer and one or two overlays are laminated to form these types of data carrying devices. Usually, the core layer is made from a rigid polymer sheet, and the overlay is made from one or more flexible polymer films.

Traditionally, a rigid vinyl plastic sheet has been used to form the core layer, and flexible vinyl plastic films have been used to form the overlay(s). Polyvinyl chloride and/or co-polymers containing vinyl chloride, collectively referred to herein as PVC, are polymers frequently used in both the core layer and the one or two overlays of these types of data carrying devices. The core layer and the one or two overlays can be held together by heat fusion of an adhesive during lamination to form data carrying devices, such as cards.

U.S. Patent 4,133,926, which issued on January 9, 1979 to Vorrier et al., discloses one example of a PVC card. Vorrier et al. disclose a laminated card containing a PVC core and a PVC overlay having an adhesive generally containing a vinyl chloride, a vinyl acetate, and a vinyl alcohol therebetween.

PVC has traditionally been used to form core layers and overlay(s) in these types of data carrying devices for a variety of reasons. PVC is a relatively

inexpensive compound that readily forms a hard plastic device when heated under pressure. In addition, PVC compounds have excellent printability so data can be easily recorded on the data carrying devices.

However, data carrying devices made of PVC have a tendency to fail under normal use conditions for frequently handled data carrying devices. These failures include severe cracking and deformation. PVC is also more susceptible than other types of polymers to fatigue and attack by other chemicals.

Due to these insufficiencies of PVC, polyesters are many times included in the structures of laminated data carrying devices, such as cards. One example of a card that contains polyester is disclosed in U.S. Patent 4,497,872, which issued to Hoppe et al. on February 5, 1985. Hoppe et al. disclose a plastic card construction including a PVC core material and layers in the overlay of polyethylene terephthalate (PET) or polyethylene (PE) and PVC.

Researchers have also developed laminated data carrying devices with core layers made of polyesters. U.S. Patent 4,522,670, which issued on June 11, 1985 to Caines, discloses a plastic card having an amorphous polyester core and layers in the overlay of PET.

With the introduction of polyester layers into data carrying devices, Applicants have found that although the PVC layers tend to melt during the lamination process, the polyester layers do not. These unmelted polyester layers tend to increase the likelihood that the laminate layers will prematurely separate. The melting temperatures of many polyesters are above those of PVC. If increased lamination temperatures are utilized during the lamination process to facilitate melting of the polyester layers, then the PVC layers begin to liquefy and flow in the press. This liquefaction interferes with the lamination process and can result in thinner than desired layers of PVC. Thus,

increasing the lamination temperature creates some undesirable processing consequences.

If the layers included in the device melt but do not liquefy and flow, then an adhesive may not be needed to securely bond the layers of the laminate to one another during lamination. However, if the layers do not tend to melt, then an adhesive should be used in order to securely bond the layers of the laminate. In general, the use of polyesters, due to their tendency not to melt during the lamination process, has increased the use of adhesives to securely bond the layers in these types of laminates.

During laminate processing, an adhesive is typically applied to a printed surface located on the core layer or on a layer in the overlay. Because the adhesive can come into contact with the inks on the printed surface, the core layer and layers in the overlay, the adhesive should be compatible with and provide sufficient bond strength to all of these materials. In addition, the adhesive should be compatible to the polymer on which the inks are applied in order to facilitate optimum adhesion. Conventional adhesives used in data carrying devices having PVC cores and overlays generally do not provide sufficient bond strength to promote optimum adhesion in polyester containing laminates.

There exists a need for a durable failure resistant laminate usable for a data carrying device, such as a card, that contains polyvinyl chloride, polyester and an adhesive, which provides sufficient bond strength to promote optimum adhesion in various layers (printed or unprinted) of data carrying devices. There also exists a need for a method of manufacturing these types of laminates usable as durable data carrying devices.

SUMMARY OF THE INVENTION

The present invention is directed toward a polymeric laminated data carrying device. A variety of devices can be made from the laminate of the invention. Essentially, the laminate can be shaped or formed in accordance with various uses and applications. One example of a device of the invention is a rigid card. Devices of the invention include a core layer and at least one overlay. In preferred embodiments of the invention, devices of the invention include two overlays--one overlay for each surface of the core layer. Preferably, each overlay has a layer of polyester therein. Uniaxially or biaxially oriented, collectively referred to as axially oriented, polyester layers are usable in the invention. If axially oriented polyester layers are used in accord with the invention, then each polyester layer is included in the device in such a manner that the axial orientation of each polyester layer is substantially parallel. As used herein, the term "substantially parallel", refers to the axial orientation of each polyester layer included in the device being sufficiently parallel to prevent the device from having a tendency to twist. In addition to the overlay having a polyester layer therein, preferably, the overlay contains a PVC layer.

The layers of the device of the invention are adhesively bonded, preferably, with a polar adhesive. The overlay layers are adhesively bonded to each other, and the overlays are adhesively bonded to the core layer. In more preferred embodiments, the core layer is polyvinyl chloride and/or co-polymers thereof (collectively referred to as PVC), and the polyester layers are polyethylene terephthalate and/or copolymers thereof. The adhesives used in the invention are most preferably, polar adhesives having functional groups therein, such as particular types of urethanes, modified acrylics and/or modified vinyls.

The core layer preferably is PVC, a polyester, or a co-polyester. Polyesters having polyethylene terephthalate (PET) therein are preferred, if a polyester or co-polyester core is used. The devices, such as cards, of the invention are durable and failure resistant. Preferred embodiments of the invention have a peel strength of at least about 4.0 pounds per linear inch (PLI) when measured according to a PEEL test described herein below. In addition, preferred devices of the invention can withstand 30,000 flexes when measured according to a STRESS test described herein below and have an impact resistance of at least about 75 inch-lb/mil (i.e. one mil is 1/1000 of an inch) when measured using an IMPACT test described below. Further, a preferred device of the invention can be stressed for at least eight days when tested according to a PLASTICIZER test described herein below, and has a thickness standard deviation of not greater than +-0.4.

The invention is also directed toward preparing the devices of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

Figure 1 illustrates a schematic cross-sectional view of a data carrying device in accord with the invention;

Figure 2 illustrates a schematic cross-sectional view of a data carrying device in accord with the invention;

Figure 3 illustrates a schematic cross-sectional view of a data carrying device in accord with the invention;

Figure 4 schematically illustrates a process for preparing devices of the invention.

DETAILED DESCRIPTION OF THE INVENTION

The present invention relates to laminates usable for durable data carrying devices, such as cards,

containing PVC, and/or polyester and adhesive and methods of manufacturing the same. The articles and methods herein focus on meeting certain product durability requirements of the end user of the data carrying device. Applicants have found that by using particular types of compounds in the layers of laminates usable in data carrying devices, and by orienting layers in a particular manner, a data carrying device having improved durability can be produced.

Typically, durability of a laminated data carrying device is ascertained by performing a variety of tests on the device. These tests include a peel test, a flex test, a stress test, and an impact test. In addition, in order to satisfy customer requirements and International Standards Organization Standards, a uniform thickness is desired. In general, the conventional peel strength required by the International Standards Organization (ISO) is about 3.4 PLI when measured in accord with the PEEL test described herein below. Conventional PVC data carrying devices, such as cards, fail after 5,000 to 8,000 flexes, when using the FLEX test described herein below. Conventional PVC data carrying devices break after 1.0 to 1.5 hours in a stressed position, stressed according to the STRESS test described herein below. Impact test values of conventional PVC data carrying devices include ranges of about 65 to 70 in-lb/mil, when measured according to the IMPACT test described herein below.

Laminated data carrying devices having greater durability are needed for many applications. For some applications, laminates having the capability of sustaining 30,000 flexes without fail, of having a peel strength of about 4.0 to about 8.0 PLI, of being stressed for eight days without breaking, and of having an impact strength of 75-80 in-lb/mil as measured by the tests described herein below are necessary.

Uniformity of thickness among laminated data carrying devices is also preferred for many applications. Typically, conventional laminated PVC data carrying devices when laminated at 280°F have a thickness with a standard deviation of about +-0.54 mil. When laminated at 300°F, conventional PVC data carrying devices have a thickness with a standard deviation of about +-0.64 mil, and when laminated at 320°F standard PVC data carrying devices have a thickness with a standard deviation of +-0.65 mil. In many applications, data carrying devices having a thickness with standard deviations of +-0.16 - 0.21 when laminated at various temperatures ranging from 280°F to 320°F are necessary. The devices having a smaller standard deviation are more desirable because they tend to have a greater uniformity, which makes them better adapted for mass processing.

The devices of the present invention are more durable than the standard laminated PVC and many polyester containing data carrying devices that do not have advantageous constructions. The laminated device constructions of the present invention minimize card failures by utilizing polar adhesives, orienting polyester layers, and insuring that polyester layers are among the outer layers of the device constructions. In preferred embodiments, the laminated device constructions include a core layer and two overlays--one adhesively bonded on each core layer surface. The overlays, in preferred embodiments, each have only two layers (i.e. one polyester layer and one PVC layer) in order to provide a durable and cost effective device. In preferred embodiments, each layer is adhesively bonded to adjacent layers with a polar adhesive that securely bonds inks, polyester layers and PVC layers. The polar adhesives more preferably are compounds having functional groups therein.

Composition and Structure of the Data Carrying Device

In general, the data carrying devices of the invention are composed of a core layer and at least one overlay. The core layer is generally a layer of a rigid uniform polyester or PVC sheet material. The overlay is generally layers of flexible polyester and/or PVC films that are adhesively bonded to one another. The core layer and overlay(s) are adhesively bonded to each other during a lamination process to form a polymeric laminate usable for a data carrying device.

The Core Layer Composition

The core layer of a polymeric laminate usable as a data carrying device, such as a card, functions generally as a primary structural component of the laminate. Because the core layer generally functions as a primary structural component of the laminate, it is usually made from a hard, rigid polymer. In addition, the core layer usually functions as the substrate onto which inks providing color and identifying information to the laminate are applied.

The core layer can include any type of polymer that provides structural integrity and stability to the laminated device. This structural integrity must be maintained during and subsequent to a laminating process. The core layer should also be capable of being adhesively bonded to an overlay and retaining inks, for example, containing data.

Generally polymers such as PVC, acrylonitrile butadiene styrene terpolymer (ABS), polyesters, polycarbonates and co-polymers thereof are usable as core layers in accord with the invention. Traditionally, PVC, which, as mentioned above, includes its co-polymers of polyvinyl chloride, is used to form core layers in data carrying devices, such as cards.

Applicant believes that due to the well-established use of PVC as the core layer for these types

of data carrying devices, most commercially available inks are adapted to print optimally on PVC core layers. Therefore, PVC containing core layers are among the most convenient to use.

Preferred embodiments of the invention include core layers made from vinyl chlorides, such as PVC. However, other polymeric materials are usable to form core layers in accord with the invention. Polyester and copolyesters have proven to be durable and to provide structural integrity subsequent to a lamination process. In particular, Applicant has found that polyesters such as polyethylene terephthalate, polybutylene terephthalate, and naphthalene terephthalate provide laminated devices with optimum durability. However, as discussed previously, for a wide variety of inks, polyester surfaces may not be as printable as PVC surfaces.

Both crystalline and amorphous polyesters can be used as core layers of the laminated device in accord with the invention. Applicant has found that for many applications crystalline polyester provides more structural integrity to the laminated device than an amorphous polyester. A crystalline polyester core layer provides the laminated device with improved physical properties when compared with an amorphous polyester core layer. Because the molecules in a crystalline sheet can be oriented to form a polyester core layer having a particular molecular orientation, the laminated device can have improved tensile strength, flexibility, tear resistance, and crack resistance. However, amorphous polyester cores can provide better surfaces for printing and adhesion. A balance of variables for each application will determine whether amorphous or crystalline polyesters should be used.

In general, the thickness of the core layer can vary with the desired end product. Typically, the

core layer thicknesses of devices of the invention are at least about 10 mil and not greater than about 26 mil. Preferably, the core layer is at least about 20 mil and not greater than about 25 mil. Most preferably the core layers of the invention are at least about 22 mil and not greater than 24 mil. These core thicknesses facilitate the overall device thickness, if the device is a card, to be within the ISO standards.

It is noted that in accord with the invention, two or more layers of core material may be laminated together to form a single core layer. For example, as is discussed more fully below, it is possible to laminate two or more rigid PVC sheets together to form a single core layer for a laminated device. Core layers in accord with the invention can be colored, transparent or opaque depending upon the end user's needs.

Core layers usable in accord with the claimed invention are usually cut from core sheets of rigid polymers. Core sheets of polymers usable in accord with the invention include: core sheets made from crystalline PET-9921 and amorphous polyester PETG-6763, which are polyesters available from Eastman Chemical Company of Kingsport, TN; Lexan 8010, which is a transparent 7 mil thick polycarbonate sheet that is made by GE Plastics and supplied by Tekra Corporation of New Berlin, WI; and 13 mil thick rigid polyvinyl chloride co-polymer sheet (CPT) made by Nan Ya Plastics of Taiwan and supplied by Rocheux International, Inc. of New Jersey.

Overlay Composition and Structure

At least one overlay typically is included in the laminated data carrying device. Usually if more than one overlay is included in the laminated device, the structure and composition of each overlay are analogous. In preferred embodiments, the laminated devices of the invention include one overlay adhesively bonded to each surface of the core layer. Generally,

the overlay includes a plurality of flexible polymeric layers adhesively bonded to each other.

The overlay(s) functions to add structural stability and integrity to the laminated device and to protect the core layer and any print thereon. In general, any transparent polymers capable of withstanding the lamination process without losing their structural integrity and capable of being adhesively bonded to one another and to the core layer prior to lamination are usable in the overlay. In general, these types of polymers include: polyesters, polyvinyl chlorides, polycarbonates, polyolefins and/or co-polymers thereof.

Applicant has found that by alternating layers of polyester and PVC, optimum structural support, durability and protection can be provided while providing additional PVC surfaces on which data can be printed and magnetic strips can be applied for additional data storage. Therefore, in the most preferred embodiments of the invention the overlay includes alternating layers of polyester and PVC. Applicant believes that devices having only polyester layers in the overlay(s) are durable but may provide fewer surfaces on which a variety of inks and/or magnetic strips can be used. As previously discussed, polyesters and/or co-polyesters are believed to substantially increase the durability of laminated data carrying devices, and PVC is a cost effective material that is receptive to most commercially available inks; therefore, in more preferred embodiments, layers of both types of polymers are included in the overlay.

In general, any type of polyester or co-polyester (collectively referred to herein as polyester) that adds durability and structural integrity to the laminated data carrying device is usable in the claimed invention. In addition, the polyester should be capable of being securely bonded to PVC layers using a polar

adhesive having functional groups therein. Typical types of polyesters usable in the overlay include: polyethylene terephthalate, polybutylene terephthalate, naphthalene terephthalate, and co-polymers thereof. Both amorphous and crystalline polyester films can be used in the overlay.

Generally, the thickness of the polyester layers is determined by the desired end product. However, if the polyester layers are too thick, then embossing of a device such as a card can become difficult. If the polyester layers are too thin, then there can be insufficient polyester in the device to improve its durability. Typically, the polyester layers in the overlay are at least about 0.5 mil thick and not greater than about 5 mil thick. Preferably, the polyester layers in the overlay are at least about 0.5 mil thick and not greater than about 2 mil thick. More preferably the thickness of the polyester layers in the overlay are at least about 0.5 mil thick and not greater than about 1.5 mil thick.

In general, Applicant has found that the durability of the laminated data carrying devices of the invention increases if chemically treated polyesters are included in the overlay(s) of the device. These chemical treatments modify the film surface and facilitate adhesion of the polyester layer to adjacent layers. More preferably, both sides of the polyester films are treated prior to being included in the laminated device. This type of chemical treatment is known to those of skill in the art. Other treatment such as corona treatment can be used as known by those of skill in the art. The following are examples of polyester films that are usable in the invention: Melinex 454, a one mil thick two sides treated film made by ICI Films and commercially available from Plastic Suppliers of South Chicago Heights, IL; Mylar 142 J 102, a 1.5 mil thick film two sides treated commercially

available from DuPont of Wilmington, DE; Hostaphan 4500, a 2 mil thick two sides treated film and Hostaphan 5000, an untreated one mil thick film made by Hoechst Celanese and commercially available from Pitcher Hamilton of Hinsdale, IL.

The same types of polyesters that are usable in the core layer are usable in the overlay layers (i.e., polyethylene terephthalate, polybutylene terephthalate and naphthalene terephthalate). The most preferred polyester is polyethylene terephthalate (PET). Preferably, as discussed more fully below, the polyester layers are included in the overlay in such a manner that the axial orientation of each polyester layer is substantially parallel. Applicant has found that orienting the polyester overlay layers in this way is necessary to obtain acceptably flat cards. Acceptably flat cards are those that meet ISO flat card standards.

In general, any flexible PVC that can withstand the lamination process and that provides some surface protection to the laminated device is usable in the overlay in accord with the invention. In addition, the PVC should be capable of being adhesively bonded, using a polar adhesive to polyester layers in order to form a laminated data carrying device. A PVC film usable in the overlay is a 2 mil thick transparent polyvinyl chloride film, ZE84 available from Hoechst Celanese of Newark, DE.

In general, the desired thickness of the PVC layers idepends upon the end use of the final product. Typically, the PVC layers included in the overlay are at least about 0.5 mil thick and not greater than about 5 mil thick. Preferably, the PVC overlay layers are each at least about 1 mil thick and not greater than about 4 mil thick. More preferably, the PVC overlay layers are each at least about 1.5 mil thick and not greater than about 2.0 mil thick. As with PVC core layers, PVC

overlay layers can provide surfaces on which data or identifying information can be recorded.

Preferably, the polymeric layers used in the overlay(s) are transparent in order to allow printed items on the core layer surface to be visible subsequent to lamination.

An adhesive is used between each of the layers in the overlay and between the overlay(s) and the core layer in order to securely bond the layers of the laminated device together. In general, the adhesive should be one that readily adheres to polyester, PVC and any types of inks used in the laminated device. Therefore, optimum adhesion and durability can be obtained. Typically the same types of adhesives can be used to bond all of the different types of layers.

Applicant has found that polar adhesives provide optimum adhesion to the surfaces of all layers in the laminated device. These types of adhesives include urethanes, modified acrylics, and modified vinyls. Preferably, polar adhesives having functional groups therein are used. Traditional adhesives include polyolefins, polyesters, vinyls and acrylics. Applicant has found that these traditional adhesives do not sufficiently secure the polyester layers to other layers in the laminated device having printed core layers therein for many applications.

Applicant has found that polar adhesives having functional groups, such as carboxyls, hydroxyls, amines, esters, amides, urethanes, epoxys, and isocyanates improve adhesion among the layers and the inks. Generally, the larger the number of functional groups the better the adhesion will be. The optimum number of functional groups will depend upon the desired laminated product, the types of layers being bonded to one another, and the types of functional groups used in the adhesive. There should be enough functional groups in the adhesive to securely bond the layers to the inks

and/or other layers in the laminated device. Preferably, there should be a concentration in the adhesive of at least about 0.0002 equivalent of functional groups per gram of adhesive based upon its solid content.

Most preferred adhesives usable in the invention include: aqueous polyurethane dispersions, acrylic dispersions and solvent based polyurethanes. These adhesives are commercially available as: polyurethane dispersions R-9621 and R-9314 from Zeneca Resins of Wilmington, MA; acrylic dispersions Cabobond 26373 and Hycar 26796 available from B.F. Goodrich of Cleveland, OH; solvent based polyurethane M6571 available from Uniroyal of Mishawaka, IN; and solvent based polyurethane Tycel 7058 available from Liofol of Cary, NC.

It is noted that some adhesive formula modifications can be made to optimize these commercial adhesive formulations. These modifications can be made to optimize processing and preparation of the laminated devices. For example, a non-blocking agent may be added to a commercially available adhesive in order to keep rolled polymer films having adhesive on one surface from sticking to itself and other layers of the polymer film. Generally, any non-blocking agent usable with polymers involved in lamination processes is usable in the invention. These non-blocking agents include a fine silica gel or an acrylic or vinyl adhesive with a high glass transition temperature (i.e. at least about 104°F). One example of a fine silica gel is Sylobloc-44 available from W.R. Grace of Baltimore, MD.

Generally, the thickness of each overlay can vary with the particular application. If the overlay is too thick, then the laminating process may become more difficult due to the larger size overlay rolls that would have to be handled and transported. Further, if the overlay is not thick enough, the core layer and

material printed upon the core layer may not be sufficiently protected. The thickness of the overlay can vary with the application. Typically, the overlay is at least about 1 mil thick and not greater than about 10 mil thick. Preferably, the overlay is at least about 2 mil thick and not greater than about 6 mil thick. More preferably, the overlay is at least about 3.5 mil thick and not greater than about 5 mil thick.

Figure 1 illustrates a preferred laminated data carrying device construction. Laminated data carrying device 9, such as card 10 includes core layer 11. In more preferred embodiments, core layer 11 is a PVC core layer 12. Core layer 11 has a surface 13 and a surface 14. Surfaces 13 and 14 provide surfaces on which data can be recorded. Information to be recorded on the card and inks or identifying information to be put on the card are generally added to one or both of surfaces 13 and 14.

Overlay 15 is adhesively bonded to surface 13. Overlay 15 includes protective layer 17, adhesive 19, polyester layer 20 and adhesive 21. Protective layer 17 in preferred embodiments is PVC protective layer 22. Polyester layer 20 in preferred embodiments is PET layer 23. Adhesive 19 securely bonds protective layer 17 to polyester layer 20. In preferred embodiments, adhesive 19 is a polar adhesive having functional groups therein. Adhesive 21 securely bonds polyester layer 20 to core layer 11. In preferred embodiments, adhesive 21 is also a polar adhesive having functional groups therein. Adhesives 19 and 21 may or may not be the same, depending upon processing requirements and the end use of the laminated data carrying device.

Overlay 24 is adhesively bonded to surface 14 of core layer 11. Overlay 24 in this Figure includes protective layer 25, adhesive 26, polyester layer 27, and adhesive 28. Overlay 24 is generally analogous to overlay 15. In preferred embodiments, protective layer

25 is PVC protective layer 29, and polyester layer 27 is PET layer 30. In preferred embodiments, adhesives 26 and 28 are polar adhesives having functional groups therein. Adhesives 26 and 28 may or may not be the same depending upon the end use of the laminated data carrying device 9.

Figure 2 illustrates another preferred laminated data carrying device construction. In this construction, core layer 11 is a polyester and in particular PET layer 40. The polyester core layer can be an amorphous copolyester or polyester. The card illustrated in Figure 2 has an overlay 41 and an overlay 42. Overlay 41 includes a polymer layer 43 which in this Figure is a flexible PVC layer 44. Overlay 42 is analogous to overlay 41. Overlay 42 includes a polymer layer 45, which in this Figure is PVC layer 46. The card in Figure 2 also includes adhesive 47, which is adjacent to core layer 40, and adhesive 48 which is also adjacent to core layer 40. These adhesives are substantially similar to adhesives 21 and 28 in Figure 1.

Figure 3 represents a third card construction in accord with the invention. Core layer 11 as in Figure 2 is PET layer 40. The card in Figure 3 has overlays 50 and 51 which are substantially similar to overlays 41 and 42 respectively in Figure 2. Overlay 50 includes a polymer layer 52, which in this Figure, is PET layer 53. Overlay 51 includes a polyester layer 54, which in this Figure is PET layer 55. Adjacent to core layer 40 is adhesive 56 and adhesive 57. In the cards depicted in Figures 1 and 3, PET layers 23 and 30 and 53 and 55 respectively are included in the device in such a manner that each of the layer's axial orientation is parallel.

Methods of Preparing the Laminated Data Carrying Device

In general, the laminated data carrying devices of the invention are prepared by: printing information or colors on a core sheet that will later be cut to the size of a core layer; adhesively bonding polyester and/or PVC layers together to form an overlay to be adhesively bonded to each surface of the core layer; and laminating the overlays to the core layer using a lamination process known to those of skill in the art. In accord with the invention, inks and data are provided on the core sheet. In most preferred embodiments, the core sheet is a rigid sheet of PVC. The inks and data can be provided on one or both surfaces of the core sheet that will later become a core layer included in devices of the invention.

Preparing the Overlay

In general, preparation of the overlay in accord with the invention, includes preparing a plurality of polymer films having an adhesive therebetween. Applicant's process typically begins by coating a surface of a flexible polymer film that becomes the overlay layer, which is closest to the core layer.

In most preferred embodiments, the overlay layer that is closest to the core layer is a polyester layer, such as a PET layer. Generally, the polyester layers within a device begin as a rolled polyester sheet provided by a film manufacturer. In preferred processes of the invention, this rolled film is typically unrolled while being coated on one surface with an adhesive and rerolled prior to being securely bonded to another polymer film, which would become another polymer layer in the overlay. This same type of processing generally is used to make each overlay in accord with the preferred device constructions of the invention. As briefly discussed above, in processes in which polyester

rolls are rerolled after one surface of the polyester sheet is coated with an adhesive, an antiblocking agent, for example, such as a silica gel, should be added to the adhesive. This anti-blocking agent facilitates unrolling of the rolled sheet having an adhesive thereon. In general, the rolls of polyester provided can be uniaxially or biaxially oriented (referred to herein collectively as axially oriented).

It is necessary to maintain parallel axial orientations among the layers of polyester throughout the device. Applicant has found that data carrying devices in which the axial orientations of the polyester layers in each overlay are not parallel tend to twist. Therefore, Applicant has developed a process for preparing the overlay that allows polyester layers each having an axial orientation to be included in the device in such a manner that the axial orientations of each are parallel.

Referring to Figure 4, which is a schematic illustration of a process in accord with the invention, a polyester roll 100, such as a PET roll is provided. This Figure illustrates two separate processing lines for ease of illustration. However, in preferred embodiments, only one processing line is used to successively prepare both overlays. It is noted that the process of the claimed invention does not require new or additional processing equipment. The durable and failure resistant devices of the invention can be obtained using conventional data carrying device processing equipment.

Typically the length of polyester film on these rolls is in the thousands of feet. Roll 100 is split evenly into two rolls 110 and 120, each of roll 110 and 120 having half as many feet of polyester on it as did the original roll. For example, if the original roll 100 contained 1000 feet, then rolls 110 and 120 each have 500 feet of polyester therein.

An adhesive is then applied to one surface of each roll 110 and 120. Any conventional coating method, such as a wire wound rod or gravure method can be used. In most preferred methods, wire wound rod coating head 130 is used to apply adhesive to polyester film or sheet surface 150, and wire wound rod coating head 140 is used to apply adhesive to polyester film or sheet surface 160. As can be seen in Figure 4, polyester sheet surface 150 is the opposing sheet surface of polyester sheet surface 160. Once surfaces 150 and 160 are each coated with adhesive, the polyester sheet or film is heated in order to set or dry the adhesive. One means of heating is by passing the sheets or film through ovens 170 and 180 at a temperature suitable to dry the adhesive (e.g. 250°F). This heating sets the adhesive so that the roll 110 having adhesive on surface 150 thereon and roll 120 having adhesive on surface 160 thereon can be rerolled into rolls 190 and 200 without severe blocking. Other means of drying or setting the adhesive are chemical reaction with or without the use of catalysts or radiation.

Roll 190 is oriented during the process in such a manner that surface 210 is coated with adhesive, and roll 200 is oriented in such a manner that surface 220 is coated with adhesive after passing through coating heads 230 and 240 respectively. The adhesive is set or dried when the polyester sheets are passed through ovens or any other drying source. Then the layers adjacent (e.g. PVC layer) to the polyester layers and oppositely disposed from the core layers in the device are laminated to surfaces 210 and 220 having adhesive thereon. Nip laminator rolls 250 and 260 or any type of means usable to bond the adhesive to polymer layers, such as PVC layers, as provided by rolls 250A and 260A respectively. The first overlay 270 and second overlay 280 are now in sheet form and rolled prior to being securely bonded to a core layer.

Laminating the Overlay to the Core

Preferably, the next process step involves laminating the first overlay 270 and second overlay 280 to core layers 300 and 290, which form core layer 310. When two sheets or core layers of a rigid polymer, such as PVC, are combined to form one core layer, printing can be performed simultaneously on the front and back of the sheets serving as core layers. For example, in most preferred embodiments, a PVC sheet of about 10 mil and a PVC sheet of about 13 mil are combined to form a core layer of about 23 mil. Prior to combining these two sheets, each sheet is simultaneously printed upon in order to reduce processing time. Sheets to be combined to form core layers are sandwiched between the two overlays and tacked. This process can be termed collation. These collated constructions are then laminated. Lamination can be by heat, chemical reaction and/or radiation depending on what is necessary to set or dry the adhesive.

In most preferred embodiments of the process, collated device constructions are put between steel plates 320 and laminated together. Hot press 330 accommodates several sets of steel plates 320, and thus can laminate several collated constructions 340 simultaneously. Generally, the temperature in the hot press is about 300°F and the pressure is about 110 psi. Typically the devices are laminated for about 17 minutes. At the end of the lamination process, the temperature of press 330 is reduced to room temperature (i.e. about 75°F) in about 15 minutes before the pressure is reduced and the laminated constructions are removed. Once removed from press 330, the devices are punched or cut out to the size desired.

Laminated Data Carrying Devices of the Invention

Laminated data carrying devices of the invention are generally durable, rigid plastic devices,

such as cards. Devices of the invention typically have peel strengths of at least about 4.0 PLI, when measured according to the following procedure, which is referred to herein as the PEEL test. More preferably, laminated devices of the invention have a peel strength of at least about 5.5 PLI and most preferably, of at least about 7.0 PLI. The laminated data carrying devices are cut into one inch wide strips. Using a razor blade, the overlay is peeled to about one inch from the core. The rest of the overlay is peeled at a 180 degree angle from the core using an Instron Tensile Tester at 2 inch per minute cross head speed. The load that is required to peel the overlay from the core layer is recorded by the Tester and the average load is reported as peel strength in pounds per linear inch.

Laminated data carrying devices of the invention typically can withstand at least 30,000 flexes without fail when flexed according to the following procedure, which is referred to herein as the STRESS test. The longer edges of the data carrying device, such as a card, are placed in a pair of jibs. One of the jibs is movable and the other is fixed. The movable jib moves in cycles and changes the distance between itself and the fixed jib. The distance cycles from 1.8125 inches to 1.525 inches. When the distance between the jibs is 1.525 inches the device is usually in the minimum flex or bent position, and when the device is 1.8125 inches, the device is in the minimum or bent position. The jib oscillates at the rate of 60 cycles per minute. The cards are observed after every 1000 cycles for cracks or evidence of failure.

The devices of the invention typically can be stressed for at least eight days without any visual signs of failure due to plasticizer attack. For this test, which is referred to herein as the PLASTICIZER test, the shorter edges of the devices are mounted in a rack with a distance between mounts of 3.1 inches.

Because most devices are longer than 3.1 inches, the device, such as a card is stressed or bent when mounted. Once mounted, a plasticizer, dioctyl phthalate, is applied to the stressed surface of the mounted devices with cotton. The devices remain in the stressed position and frequently observed for failures such as cracks.

The devices of the invention have an impact resistance of at least about 75 inch-lb/mil when measured according to ASTM D-4226, which is referred to herein as the IMPACT test. In addition, devices of the invention have a device thickness standard deviation of not greater than +-0.4 mil. More preferably, the standard deviation for device thickness is not greater than +-0.25 mil.

WORKING EXAMPLES

For each of the examples, the below described process was used to prepare laminated devices of the invention. In each of the following examples, the overlays were prepared by coating the named polyester film using a wire wound rod with the named adhesive. For the first example, one surface of half of a one hundred foot roll of PET film was coated with 8 pounds/ream of an adhesive containing R9314 plus 1.2 weight percent Sylobloc44. The surface closest to the roll when the roll is being unrolled was coated and this was the PET for the first or front overlay. Once applied to the surface, the adhesive was dried by passing the film through an oven at 280°F.

The remaining PET film roll is the PET to be used in the second or back overlay. The same adhesive used on the front overlay was used on the back overlay. The adhesive was applied to the opposite surface of this roll in order to properly orient the polyester layers. This surface of the PET was coated with 8 pounds per ream of the same adhesive and dried accordingly.

The second surface of the film in the first overlay roll was then coated with 8 pounds per ream of an adhesive containing the R9314 without the Sylobloc added therein. The film was dried in an oven at the above-mentioned temperature. As the coated PET film exited the oven, it was laminated with a PVC film or protective layer in a nip laminator. The PVC film was laminated to the side of the PET film that has the R9314 adhesive without the anti-blocking agent. The second surface of the film in the second overlay roll was coated with 8 pounds per ream of the same adhesive that was used to coat the second side of the film in the first overlay roll. The adhesive on the second surface of the PET film in the second overlay roll was dried as previously discussed, and PVC film was laminated in a nip laminator to this second side of the coated PET film. The two sets of overlay sheets, first and second, are now complete.

PVC core sheets 13 mil thick and 10 mil thick were cut into 3.5 in X 5.0 in sheets. The overlay sheets were also cut into 3.5 in X 5.0 in sheets. One 13 mil and one 10 mil core sheet were covered on one side by a first overlay sheet and a second overlay sheet, and then the two cores having the overlays on their outer surfaces were placed together and put between two stainless steel plates. Nine of these constructions were placed in a preheated Carver hot press, which was set to a temperature of 280°F. This stack of sheets was compressed between the two plates under about 2800 pounds of force. After about 17 minutes, the pressure was released and the stack was transferred into a similar water cooled press. A force of 3000 pounds was applied for 15 minutes to the stacked sheets while in the water cooled press. After 15 minutes, the nine laminated sheets are removed from the press and each cut into the appropriate size card. For

these examples, cards that were 3.375" X 2.105" were obtained.

Example 1

A six inch wide Hostaphan 4500 PET film was coated and processed to obtain a set of overlays as stated above. The PVC core sheets were screen printed with an ink having vinyls and/or acrylics therein. Using the PEEL test described above, this card had a peel strength of 5.6 PLI. When the PVC core sheet was lithographed with an ink having drying oils therein, the peel strength as measured using the above-identified test was 7.7 PLI.

Example 2

The same procedures were followed to make the overlays and cards as in Example 1. The first side of each polyester layer was coated with R9314 having 1.2 wt-% Sylobloc-44 therein. The second side was coated with R9621. The peel strength for the screen printed core layer (i.e., vinyl/acrylic ink) was 6.7 PLI and for the lithographed core layer (i.e., oil ink) was 6.0 PLI.

Example 3

The same process used in Example 1 was used in Example 3. The adhesive used in this example was Tycel 7058, and it was applied to both surfaces of the PET Hostaphan 4500 film. The coat weight in this example was 6 pounds per ream as opposed to 8 pounds per ream in the previous examples. The PVC core layer was screen printed with an ink having vinyl/acrylic therein, and the peel strength of the card as measured by the above-identified peel test was 5.0 PLI. When the core layer was lithographed with an oil ink, the peel strength according to the PEEL test was 4.0 PLI.

Example 4

The adhesives used in Example 1 were also used in this example. The polyester layers were made from Melinex 454. When the PVC core was screen printed with a urethane ink, the peel strength obtained using the PEEL test was 5.5 PLI. When the PVC core layer was screen printed with a vinyl/acrylic ink, the peel strength obtained was 7.8 PLI. When the PVC core layer was lithographed with an oil ink, the peel strength was 6.0 PLI. When no ink was applied to the PVC core layer, the overlay film tore after 6.5 PLI. The devices prepared in this example also sustained 50,000 flexes without fail when measured according to the above-identified STRESS test. In addition, the devices prepared in this example, also were stressed for eight days without any effect measured in accordance with the previously discussed STRESS test. The device of this example had an impact resistance of 75 to 80 inch pounds per mil when measured according to the above-identified IMPACT test.

Example 5

A data carrying card of the invention was obtained by using Melinex 454 as the polyester film in the overlay and applying R9621 adhesive having 1.2% by weight Sylobloc-44 silica gel therein to one surface of the PET film while pure R9621 adhesive was applied to the second surface of the PET film. About 8 pounds per ream of adhesive were added to the polyester sheets that became the polyester layers.

Example 6

A data carrying card of the invention was obtained by using Melinex 454 as the polyester film in the overlays and an R9314 adhesive having the anti-blocking agent therein as described in Example 5 on one surface of the polyester and pure R9621 as the adhesive

on the other surface of the polyester. The polyester film was coated with about 8 pounds per ream of each adhesive.

Example 7

Data carrying cards of the invention were made by using Mylar 142J102 as the polyester film in the overlays and R9314 plus the above-identified anti-blocking agent of Example 5 and pure R9314 as adhesives. The polyester film was coated with about 8 pounds per ream of each adhesive. The card of this example had a PVC core layer screen printed with a urethane ink, and it had a peel strength of 6.3 PLI when measured by the PEEL test. A card of this example also had a PVC core layer screen printed with a vinyl/acrylic ink and it had a peel strength of 7.4 PLI. A card having an oil ink lithographed on the PVC core layer had a peel strength of 6.3 PLI. The card made according to this example having no ink on the PVC core layer had a film tear after 6.5 PLI.

Example 8

Cards of the invention were made using Melinex 454 as the polyester film in the overlays. A R9314 adhesive with a 1.2% by weight Sylobloc-44 anti-blocking agent applied to one surface of the polyester film in each overlay, and an adhesive containing 50% by weight R9314 and 50% by weight R9621 was applied to the other surface of the polyester film in each overlay. The adhesives were applied to the polyester film in an amount of 8 pounds per ream.

Example 9

In this example, polyester films in the overlays were made from Melinex 454, and one surface of the polyester film was coated in an amount of 8 pounds per ream with R9314 having a blocking agent in an amount

of 1.2% by weight therein of Sylobloc-44. The second surface of the polyester film was coated with an adhesive having 75% by weight R9314 and 25% by weight R9621. A durable and rigid card in accord with the invention was obtained.

Example 10

As in the previous two examples, the polyester films in the overlay were Melinex 454. The adhesive applied on each side of the polyester was Hycar 26796. The adhesive was applied to each surface of the polyester layer in an amount of about 8 pounds per ream. A durable and rigid card of the invention was obtained.

Example 11

As in the previous three examples, the polyester films in the overlays were made from Melinex 454. The polyester film was coated on each side with Cabobond 26373 in an amount of about 8 pounds per ream. The resulting card was rigid and durable in accord with the invention.

Example 12

In this example, cards were made having untreated polyester films therein of Hostaphan 5000. One surface of the polyester film was coated with an adhesive having R9314 with 1.2% by weight of Sylobloc-44 as an anti-blocking agent therein, and the other surface was coated with pure R9314. Each surface was coated with the adhesive in an amount of 8 pounds per ream. The resulting card was a rigid and durable card in accord with the invention.

Example 13

Polyester films of Hostaphan 5000 were corona treated and used in the overlays. In the examples prior to Example 12, chemically treated polyester films were

used. Each surface of the corona treated polyester film was coated with an adhesive. One surface was coated in an amount of 8 pounds per ream with an adhesive having R9314 and 1.2% by weight of Sylobloc-44 therein. The other surface was treated with pure R9314. For those cards in which the PVC core layer was screen printed with urethane, the peel strength was 6.0 PLI when measured according to the PEEL test. When the PVC core layer was screen printed with a vinyl/acrylic ink, the peel strength was 5.9 PLI when measured in accord with the PEEL test. When the PVC core was lithographed with an oil ink, the peel strength was 4.6 PLI.

Example 14

The polyester films within the overlays in this example were made from Melinex 454 and coated on one surface with an adhesive having R9314 and 1.2% by weight Sylobloc-44 on one surface and an adhesive containing 75% by weight R9314 and 25% by weight R9621 coated on the second surface. Each surface had adhesives coated in an amount of 8 pounds per ream. The cards were laminated using a 22 mil thick blank white amorphous polyester PETG6763 sheet as the core layer. The peel strength for this card which had no ink applied to the PVC core layer was 4.9 PLI.

Example 15

The same polyester films and adhesives were used as an in Example 14. The cards in this example were laminated from overlays using a 22 mil thick blank white crystalline polyester sheet as the core layer. This core layer had no ink put thereon and had a peel strength of 5.4 PLI when measured using the PEEL test.

Example 16

The same polyester films in the overlays and adhesives were used as described in Example 14. The cards were laminated from these overlays using three 7 mil thick blank polycarbonate sheets as the core layer. The center polycarbonate sheet was coated with a polyester adhesive, commercially available as Adcote 109-42 from Morton International of Illinois, on both the sides to get adhesion between the polycarbonate sheets. This transparent core layer having no ink thereon provided a card with a peel strength of 5.5 PLI.

What is Claimed is:

1. A polymeric laminated data carrying device comprising:

(a) a core layer having a first surface and a second surface;

(b) a first polyester layer having a first axial orientation and being adhesively bonded to the first surface of the core layer; and

(c) a second polyester layer having a second axial orientation and being adhesively bonded to the second surface of the core layer;

wherein the first and second polyester layers are adhesively bonded in such a manner that the first axial orientation is substantially parallel to the second axial orientation.

2. A device in accordance with claim 1 wherein the first axial orientation is a biaxial orientation and the second axial orientation is a biaxial orientation.

3. A device in accordance with claim 1 wherein a first protective layer is adhesively bonded to the first polyester layer and a second protective layer is adhesively bonded to the second polyester layer.

4. A polymeric laminated data carrying device comprising:

(a) a core layer having a first surface and a second surface;

(b) a polar adhesive;

(c) a first overlay, said first overlay being adhesively bonded with the polar adhesive to the first surface of the core layer and said first overlay comprising:

(i) a first polyester layer having a first axial orientation;

(d) a second overlay, said second overlay being adhesively bonded with the polar adhesive to the second surface of the core and said second overlay comprising:

(i) a second polyester layer having a second axial orientation.

5. A device in accordance with claim 4 wherein the first and second polyester layers are included in the device in such a manner that the first axial orientation is substantially parallel to the second axial orientation.

6. A device in accordance with claim 4 wherein the core layer comprises polyvinyl chloride or its copolymer.

7. A device in accordance with claim 4 wherein the first and second polyester layers comprise polyethylene terephthalate.

8. A device in accordance with claim 4 wherein the polar adhesive has functional groups therein.

9. A device in accordance with claim 8 wherein the adhesive is selected from a group consisting of urethanes, modified acrylics and modified vinyls.

10. A device in accordance with claim 4 wherein the first overlay comprises a first protective PVC layer or its copolymer layer, said first protective layer being adhesively bonded with the polar adhesive to the first polyester layer; and wherein the second overlay comprises a second protective PVC layer or its copolymer, said second protective layer being adhesively bonded with the polar adhesive to the second polyester layer.

11. A device in accordance with claim 4 wherein the core layer comprises polyethylene terephthalate.

12. A device according to claim 1 wherein the device has a peel strength of at least about 4.0 PLI when measured according to PEEL test.

13. A device according to claim 1 wherein the device can withstand 30,000 flexes when measured according to STRESS test.

14. A device according to claim 1 wherein the device has an impact resistance of at least about 75 inch-lb/mil when measured using IMPACT test.

15. A device according to claim 1 wherein the device can be stressed for at least eight days when tested according to PLASTICIZER test.

16. A device according to claim 1 wherein the device has a thickness standard deviation of not greater than +-0.4 mil.

17. A polymeric laminated data carrying device comprising:

(a) a core layer, said core layer having a first surface and a second surface;

(b) a first overlay, said first overlay being adhesively bonded to said first surface of said core layer with a first polar adhesive having functional groups therein and said first overlay having therein a first layer adhesively bonded to a second layer, said second layer being a polyester layer having a first axial orientation and said first layer being a protective layer; and

(c) a second overlay, said second overlay being adhesively bonded to said second surface of said core

layer with a second polar adhesive having functional groups therein and said second overlay having therein a first layer adhesively bonded to a second layer, said second layer being a polyester layer having a second axial orientation and said first layer being a protective layer;

wherein said polyester layers are included in the device in such a manner that the first axial orientation of said polyester layer is substantially parallel to the second axial orientation of said polyester layer.

18. A polyester laminated data carrying device comprising:

(a) a core layer, said core layer having a first surface and a second surface;

(b) a first overlay, said first overlay being adhesively bonded to said first surface of said core layer with a polar adhesive and said first overlay having a first layer and a second layer therein.

19. A data carrying device of claim 18 comprising:

(a) a second overlay, said second overlay being adhesively bonded with a polar adhesive to said second surface of said core and said second overlay having a first layer and a second layer therein.

20. A method for preparing a polymeric laminated data carrying device, said method comprising steps of:

(a) selecting a first length of axially oriented polyester film having a first surface and a second surface;

(b) selecting a second length of axially oriented polyester having a first surface and a second surface;

(c) coating the first surface of the first length of the polyester film with an adhesive;

(d) coating the second surface of the second length of the polyester film with an adhesive;

(e) adhesively bonding the first surface of the first length of the polyester film to a first surface of a core layer; and

(f) adhesively bonding the second surface of the second length of the polyester film to a second surface of the core layer.

21. A method for preparing a polymeric laminated data carrying device, said method comprising steps of:

(a) preparing a first overlay, said step of preparing a first overlay comprising:

(i) providing a first polyester layer having a first axial orientation;

(ii) adhesively bonding said first polyester layer to a protective layer;

(b) preparing a second overlay, said step of preparing a second overlay comprising:

(i) providing a second polyester layer having a second axial orientation;

(ii) adhesively bonding said second polyester layer to a protective layer,

(c) adhesively bonding the first overlay to a first surface of a core layer and the second overlay to a second surface of the core layer in such a manner that the first axial orientation is substantially parallel to the second axial orientation.

22. A method according to claim 21 wherein said method comprises a step of heat laminating the device.

23. An overlay useable in a polymeric laminated data carrying device, said overlay comprising;

(a) a polyester layer having an axial orientation; and

(b) a protective layer, said protective layer being adhesively bonded to the polyester layer with a polar adhesive having functional groups therein.

24. An overlay in accordance with claim 23 wherein the adhesive is selected from a group consisting of urethanes, modified acrylics, and modified vinyls.

25. An overlay in accordance with claim 23 wherein the polyester layer has a biaxial orientation.

26. An overlay useable in a polymeric laminated data carrying device, said overlay comprising;

(a) a polyester layer having a biaxial orientation; and

(b) a protective layer, said protective layer being adhesively bonded to said polyester layer with an adhesive selected from a group consisting of urethanes, modified acrylics, and modified vinyls.

27. An overlay in accordance with claim 26 wherein the protective layer includes PVC.

FIG. 1

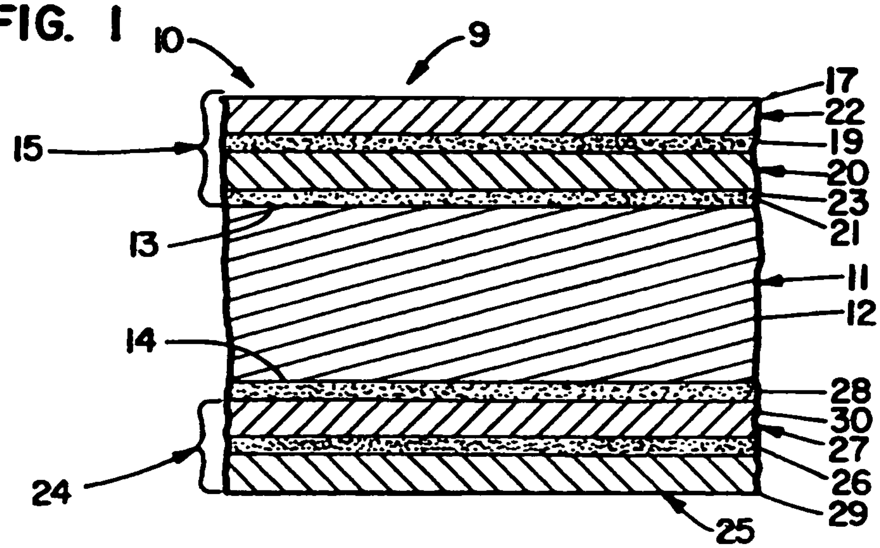


FIG. 2

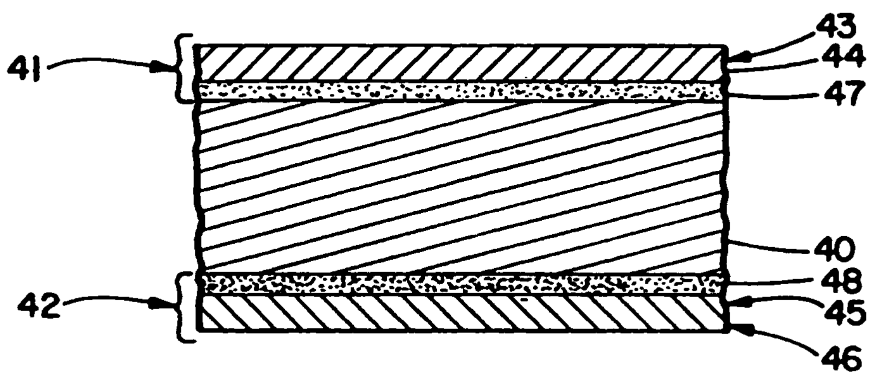
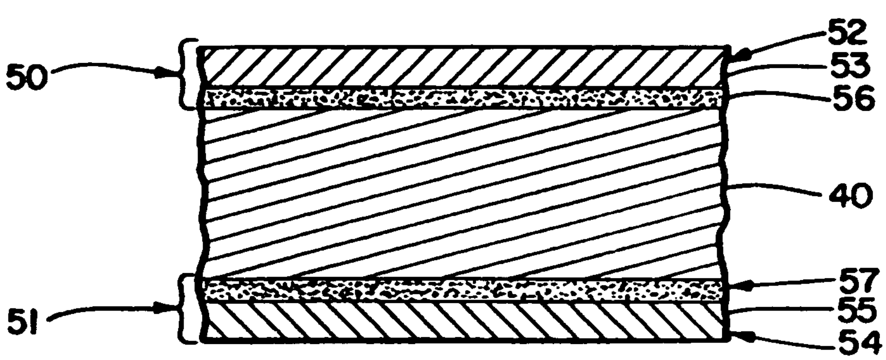


FIG. 3



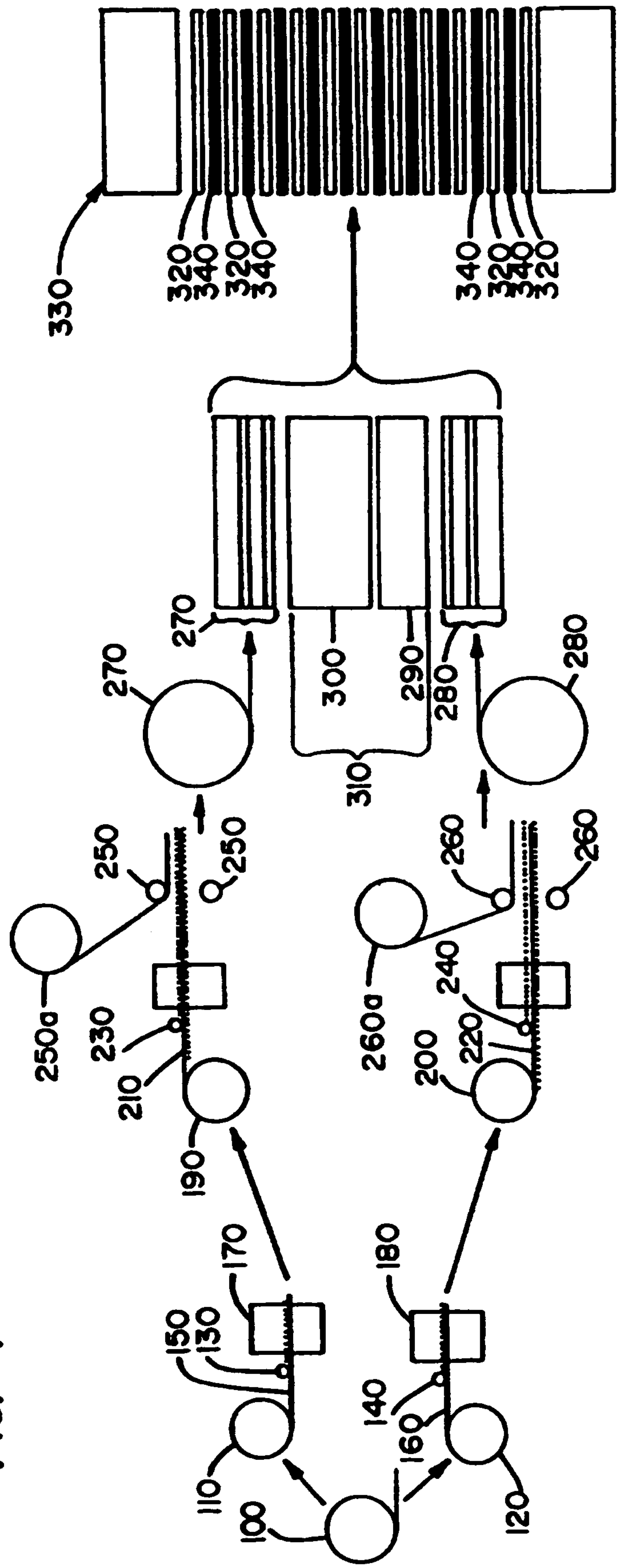

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FIG. 4